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Method of Calculating Blade-to-Blade Plane Flow in Centrifugal Pump

A simple stream-filament solution has been devised for determining the velocity distribution due to potential flow in the blade-to-blade plane of a radial impeller in a centrifugal pump.

The blade-to-blade flow is first assumed to take place on an axisymmetric stream surface. Given the blade geometry on this surface, the problem is reduced to finding the two-dimensional potential flow through the resulting cascade. The passage between adjacent blades is divided into three regions separated along lines normal to the blade surfaces. These regions are the channel-flow region (where the blades overlap), the entrance region, and the exit region. A stream filament method (essentially the method of Flugel) is used to determine the flow in the channel region of the passage. Because the streamlines downstream of the channel-flow region are not known without the use of an "exact" (e.g., relaxation) solution, the indiscriminate use of the stream-filament method would not correctly indicate the fluid "slip" (or deviation from blade direction) that occurs in the channel. The procedure used to circumvent this problem is to fix the streamline curvature and velocity distribution at the exit of the channel-flow region based on an acceptable slip correlation (such as Pfleiderer's). This essentially fixes a boundary condition for the stream-filament solution obtained further upstream in the channel, and appears to give a good prediction of the way in which the fluid slip or deviation is distributed in the passage. Thus, the procedure allows a determination of the flow distribution in the channel-flow portion of the passage. The velocity distribution on the blades in the other two regions is approximated through application of the Kutta condition and a circulation balance over these regions. The resulting velocity distribution is then used to determine the mass-averaged relative fluid angle, which is in turn used in an existing axisymmetric program to obtain improved stream surfaces of the assumed axisymmetric flow.

Note:

The following documentation may be obtained from:

Clearinghouse for Federal Scientific
and Technical Information
Springfield, Virginia 22151
Single document price $3.00
(or microfiche $0.65)

Reference:
NASA-CR-80153 (N67-12915), Study of Pump Discharge Pressure Oscillations, Final Report.

Patent status:

No patent action is contemplated by NASA.

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